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Smaller Prostate Volume, Lower Bladder Outlet Obstruction and Detrusor Contractility in Male Patients with Neurogenic Lower Urinary Tract Symptoms Compared to Benign Prostatic Hyperplasia

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Abstract | **Original Research Article**

Objectives: Increasing prevalence of benign prostate hyperplasia (BPH) with age generates a need for differentiation of benign prostatic obstruction (BPO) due to BPH from neurogenic lower urinary dysfunction (NLUTD) in male patients with neurological diseases. ***Material and Methods***: The clinical data of patients with spinal cord injury (SCI) or BPH alone underwent sonography videourodynamic studies (SVUDS) from Oct 2020 to Oct 2024 in the Second Affiliated Hospital of Guilin Medical University was retrospectively reviewed. Age, prostate volume (PV), peak flow rate (Qmax), post-voiding residual (PVR), bladder obstruction index (BOOI), and bladder contractility index (BCI) were compared between SCI patients with neurogenic lower urinary tract symptoms (NLUTS) and BPH patients with non-NLUTS (NNLUTS). ***Results***: 8 male patients with SCI and NLUTS and 10 patients with NNLUTS due to BPH were recruited into this study. Lower age (49.3±9.9 years vs. 65.3±7.8 years), smaller PV (18.6±6.4 vs. 83.4±41.3ml), larger PVR (402.5±198.7 vs. 108.5±78.5ml), lower BOOI (21.0±10.9 vs. 98.3±40.8) and BCI (69.4±32.1 vs. 150.0±46.1) in patients with SCI and NLUTS were detected compared to BPH with NNLUTS (all $P < 0.05$). However, there was not a difference of Qmax between two groups between two groups (7.0±5.9 vs. 6.0±2.8ml/s, P=0.632). ***Conclusions***: It was suggested that a milder BOOI and BCI, which leaded to a larger PVR, attributed to a smaller PV due to a lower traumatic age and denervation and the characterization of UDS images in SCI patients may facilitate the differentiation of NLUTS from NNLUTS.

Keywords: Neurogenic Lower Urinary Tract Symptoms, Spinal Cord Injury, Non-Neurogenic Lower Urinary Tract Symptoms, Benign Prostate Hyperplasia, Sonography Videourodynamic Studies.

INTRODUCTION

Lower urinary tract symptoms (LUTS) has been reported to be one of the most common clinical complaints in adult male and the incidence of LUTS increase with age and varies depending on countries, research cohorts and race [1]. LUTS, including storage, voiding and post-micturition symptoms, has long been regarded as the results from bladder outlet obstruction (BOO) derived mostly from benign prostate hyperplasia (BPH) in old men. However, beside BPH, some other pathophysiological conditions, such as lower urinary tract infection (LUTI) and neurological diseases, also contribute to LUTS [2].

BOO, detrusor underactivity (DU), and detrusor overactivity (DO) are urodynamic diagnosis, representing the most common conditions of bladder dysfunction on account of benign prostatic obstruction (BPO), which are generated through urodynamic studies (UDS) [3]. Thicker bladder wall and higher intravesical pressure are need to overcome an increased urethral resistance due to BOO, which causes DO due to structure change of bladder wall and DU will be followed without effective treatment for BOO. The above mentioned mechanism of lower urinary tract dysfunction (LUTD) has been confirmed in male patients with BPO, but the pathogenesis of DU and DO in neurological bladder (NB) has been proved to be different from BPO.

Neurogenic lower urinary tract symptoms (NLUTS) represents LUTD resulted from central or peripheral neurological damage, including spinal cord injury (SCI), stroke, parkinson's disease, and diabetes mellitus and so on, which we refer to as neurogenic bladder (NB). However, non-neurogenic lower urinary tract symptoms (NNLUTS) was associated with some clinical conditions, expect for NB, contributed to changes in anatomy or/and function of lower urinary tract and BPH is the most common cause of NNLUTS in old men without NB(4). There has been reported to exist inconsistent presentation of urinary biomarkers in human being and molecular characterization in mouse models between non-neurogenic lower urinary tract dysfunction (NNLUTD) and neurogenic lower urinary tract dysfunction (NLUTD) [5, 6].

In our previous studies, varied features among patients with different size prostate undergoing surgery of elimination for BOO were found using sonography videourodynamic studies (SVUDS) [7]. To my best knowledge, there has been few studies in clarification of characterization of SVUDS for patients with NB in the literature. In the present study, we found that lower age, smaller prostate volume, larger post-voiding residual (PVR), and lower value of bladder outlet obstruction index (BOOI) and bladder contractility index (BCI) in men patients with NLUTS compared to NNLUTS by means of SVUDS.

MATERIALS AND METHODS

Clinical data of male patients with NNLUTS and NLUTS underwent SVUDS from Oct 2020 to Oct 2024 in the Second Affiliated Hospital of Guilin Medical University were retrospectively reviewed. Male patients with NLUTS suffering from SCI were recruited and comparable male patients with NNLUTS were selected randomly in this study. The exclusion criterions of male patients with NNLUTS were voiding volume <150 mL, previous prostatic surgery, urethral stenosis, neurogenic bladder, utilization of medication that affects micturition, proven prostate or bladder carcinoma, and pelvic radiotherapy. Patients with abnormal urinalysis received treatment prior to TURP.

The SVUDS combined an sonography scan with multichannel UDS (Aquarius XT, Laborie, USA) and could synchronously integrate urodynamic measurement values with sonographic images by a analysis software (UDS.V14). prostate volume (PV) was calculated by a single urologist through transabdominal ultrasound scan (DC-65, Mindray, China) at a bladder volume of less than 100 mL during SVUDS and PVR was measured after micturition of SVUDS using 4-MHz curvilinear probe according to our previous reports [8]. Peak flow rate (Qmax), detrusor pressure at Qmax (Pdet.Qmax), BOO index (BOOI; calculated as Pdet.Qmax-2Qmax) ,and bladder contractility index (BCI; calculated as Pdet.Qmax+5Qmax) were obtained during pressure-flow study of SVUDS. Patients age was also recorded in this study. All SVUDS were underwent by a urologist in according with the Good urodynamic Practices of International Continence Society [9].

All patients were divided into two groups, including male patients with NNLUTS (NNLUTS group) and NLUTS (NLUTS group), and normality was explored in all parameters, including age, PV, PVR, BOOI, and BCI, by Shapiro-wilk test and data was presented as mean±standard deviation if normality distribution or median (25th percentile, 75th percentile) if non-normality. T test if normality or Mann-Whitney U test if non-normality was adopted to detect the difference of parameters. All statistical analyses were performed using SPSS for Windows (version 27.0, IBM Corp., Chicago, IL, USA). A p-value of <0.05 was considered statistically significant.

RESLUTS

8 male patients with SCI and NLUTS and 10 patients with NNLUTS due to BPH were recruited into this study and all parameters were normality distribution and T-test was conducted to investigate the difference between two groups. The age (49.3±9.9years), PV (18.6±6.4ml), BOOI (21.0±10.9), BCI (69.4±32.1) of male patients with SCI and NLUTS was significantly respectively lower than that (65.3±7.8years, 83.4±41.3ml, 98.3±40.8, 150.0±46.1) of NNLUTS with BPH (all $P < 0.01$) (Table 1). The PVR (402.5±198.7ml) of male patients with NLUTS was significantly larger than that (108.5±78.5ml) of NNLUTS ($P < 0.01$) (Table 1). There was not a difference of Qmax (NLUTS:7.0±5.9ml/s vs. NNLUTS:6.0±2.8ml/s) between two groups ($P=0.632$) (Table 1).

Table 1: Comparison of parameters between male patients with NLUTS and NNLUTS

	NLUTS（n=8）	NNLUTS(n=10)	t	*P*
Age(years)	49.3±9.9	65.3±7.8	3.854	＜0.01
Qmax(ml/s)	7.0±5.9	6.0±2.8	0.488	0.632
PV(ml)	18.6±6.4	83.4±41.3	4.373	＜0.01
PVR(ml)	402.5±198.7	108.5±78.5	4.304	＜0.01
BOOI	21.0±10.9	98.3±40.8	5.190	＜0.01
BCI	69.4±32.1	150.0±46.1	4.173	＜0.01

Abbreviations: NLUTS: neurogenic lower urinary tract symptoms; NNLTUS: non-neurogenic lower urinary

tract symptoms; PV: prostate volume; PVR: post-voiding residual; BOOI: bladder outlet obstruction index; BCI: bladder contractility index

It was suggested that the non-invasive parameters of urodynamic studies (Qmax) has not a capacity of differentiation between male patients with SCI and BPH, but sonography test (PV and PVR) and invasion urodynamic parameters (BOOI and BCI) might be used to discern the distinction of NLUTS from NNLUTS. It was not surprising that age of male patient with SCI was lower than BPH due to increased incidence of BPH with age. However, it was suggested that SVUDS had the capacity of differentiation since it could synchronously integrate urodynamic measurement values with sonographic images.

Figure 1 and 2 was respectively the classic urodynamic images of male patients with NLUTS derived from SCI and NNLUT due to BPO. Poor detrusor stability without obviously decreased compliance, regular micturition cycles, and higher intravesical pressure associated with low uroflow were more common in patients with BPO (Figure 1) than SCI (Figure 2), in which significantly decreased detrusor compliance and followed urine leak after increased intravesical pressure was representative images of UDS in patients with SCI.

Figure 1: Poor detrusor stability without obviously decreased compliance, regular micturition cycles, and higher intravesical pressure associated with low uroflow was detected by SVUDS in NLUTS patient with BPO

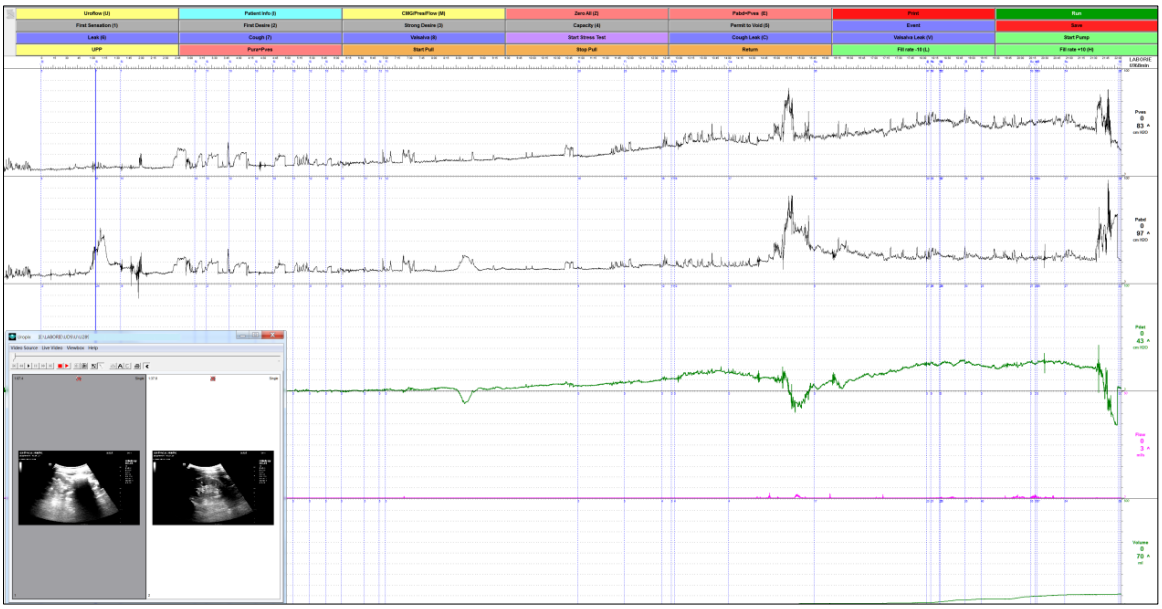

Figure 2: Decreased detrusor compliance and followed urine leak after increased intravesical pressure was detected by SVUDS in NNLUTS patient with SCI

DISCUSSIONS

Increased incidence of LUTS with age in men adult has been regarded as a consequence of increased prevalence BPO due to enlargement of prostate volume with age. LUTS always was one common most clinical complaints in patients with neurological disorder and might be initially overlooked due to postponed presentation of severe urinary complications, including recurrent urinary tract infections, vesicoureteral reflex, and chronic kidney impairment, derived from NLUTD, such as detrusor external sphincter dyssynergia (DESD), high intravesical pressure at storage phase, and high detrusor leak point pressure (DLPP).

However, analogous clinical conditions, for example frequency, urgency urinary incontinence (UUI) and intermittent micturition, might be derived from different pathogenesis of patients with NNLUTS or NLUTS, then there was a urgent need to differentiate NLUTD from NNLUTD in adult men since increased prevalence of BPH with age. In this study, lower age, smaller PV, larger PVR, and lower BOOI and BCI were discerned in SCI patients with NLUTS compared to that of BPO with NNLUTS, but there was not a difference between Qmax of BPO patients and the uroflow of urine leak in SCI patients. The present study may be the first observational research to explore the difference above mentioned by SVUDS in the literature.

There was a knowledge that increasing incidence with age and more than 50% of men adult has been reported to be diagnosed with BPH in their 50-year. Therefore, higher age of patients with NNLUTS might be attributed to older patients with BPH compared to SCI in the present study. Although there was not a statistical research in real world about the most vulnerable age of patients suffering from spinal cord injury across Chinese mainland, male adult of working age, 39.4±14.3 years, reported in Wuhan of a central metropolis in China, should endure higher risk of trauma leading to SCI [10]. Although 49.3±9.9 years in this study was higher than Wuhan's study, it was suggested that postponed perception of NNLUTS in patients with SCI may not be an unusual condition in the central and western regions of China mainland, which may contribute to increased urinary complications of SCI patients.

Qmax is a non-invasive parameter of UDS for evaluation of bladder function, but the extent of BOO or detrusor contractility can't be assessed by Qmax alone. Therefore, both DESD and detrusor compliance affect the speed of urine leak, which was represented by Qmax, in SCI patients. Although there has been a consensus that prostate size does not parallel the grade of BOO in BPH patients, it has also been found that larger PV has a tendency of higher BOOI and BCI in my previous study [7]. In line with my previous finding, patients with NNLUTS had a larger PV than NLUTS, which may be attribute to BPH in recruited patients with NNLUTS due to exclusion criterion of this group.

BOOI has been considered the most common invasive parameters of UDS for measurement of BOO [11]. Lower BOOI was found in NLUTS patients with SCI compared to NNLUTS with BPO, which can be explained by smaller PV of NLUTS patients due to both a lower age of traumatic SCI patients compared to BPH and the atrophy of prostate gland on account of denervation due to SCI in this study [12]. Detrusor contractility can be represented by invasive parameters, such as BCI, maximum wat factor (WFmax), and maximum detrusor pressure during micturition (Pdet.max), and BCI is the most used one [13]. In the present study, increased BCI was detected in NNLUTS patients due to compensation of detrusor for coming over BOO contrary to a significantly lower value of BCI in NLUTS group. However, there was an enigma in this study that there was not an increased BOOI due to DESD in NLUTS patients with SCI but a low one closing to non-BOO extent of less than 20, which need a further study of larger sample for clarification.

Beside invasive and non-invasive parameters of SVUDS for differentiation between patients with NNLUTS and NLUTS, the analysis of image of UDS may play a more potent role. As the figure 1, there was normal micturition cycles with distinct storage and voiding phases in BPH patients with NNLUTS. However, increasing intravesical pressure during filling followed by detrusor oscillation and numerous contractions at high intravesical pressure was observed in SCI patients with NLUTS, which leaded to a failure to efficiently voiding and a larger PVR compared to BPH and NNLUTS as figure 2. Our finding was supported by Michelle'study, in which characters of UDS and molecular expression between mouse models of SCI and partial BOO (PBOO) has been investigated [6].

Several limitations of the present study should be carefully noted. Firstly, the medical data in this study were retrospectively reviewed for clinical purposes, not for research aim. Secondly, the small sample of subjects made us to be cautious for generalization of the conclusion of this study in clinical practice. Therefore, more general populations, such as female and male patients with other neurological diseases rather than SCI alone, may facilitate generalizability of our finding.

CONCLUSIONS

In the present study, SCI patients with NLUTS and BPH patients with NNLUTS were recruited to investigate the differences in SVUDS between NLUTS and NNLUTS. There was a lower age, PV, BOOI, and BCI and a larger PVR in SCI patients with NLUTS compared to BPH with NNLUTS. It was suggested that a milder BOOI and BCI, which leaded to a larger PVR, attributed to a smaller PV due to a lower traumatic age and denervation and the characterization of UDS images in SCI patients may facilitate the differentiation of NLUTS from NNLUTS.

Declaration of Interests: The authors declare no conflict of interest.

Author Contributions

Pan GY and XN led in conceptualization and writing the original draft. All other authors contributed to reviewing and editing the manuscript.

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